ORBITAL ANOMALIES IN GODDARD SPACECRAFT

1985

WILLIAM G. ELSEN

SEPTEMBER 1986

ASSURANCE REQUIREMENTS OFFICE

OFFICE OF FLIGHT ASSURANCE

NASA/GODDARD SPACE FLIGHT CENTER

Summary

This report presents a summary of the in-orbit reliability performance of spacecraft built under the management of the Goddard Space Flight Center and which were active during calendar year 1985. It is one of a series of such reports that collectively form a continuous published record of this performance. The major feature of these reports is a log of all anomalies occurring during the report period which provides a description of the anomaly and its time of occurrence. Each anomaly is classified according to criticality, type, subsystem, and other relevant criteria. Although some statistical analysis and comparisons are given, the purpose of the report is primarily documentary, with more extensive statistical treatment to be presented elsewhere.

Introduction

Since the earliest days of the Center, attempts have been made to record the performance of Goddard-managed spacecraft. Although statistical summaries exist, until the last decade or so the actual raw data was considered sensitive and was not published. This is unfortunate, since over the years it has been observed that the potential uses for this data are open-ended and cannot be predicted in advance. Hence, any pre-digested data is likely not to be what is needed in any given instance.

The first report to contain specific anomaly data was the contractor report Analysis of Spacecraft On-Orbit Anomalies and Lifetimes, PRC R-3579, dated 10 February 1983, which covers roughly the period from 1978 to mid-1982, and includes JPL as well as GSFC spacecraft. This was followed by Orbital Anomalies in Goddard Spacecraft 1982-1983 and Orbital Anomalies in Goddard Spacecraft- 1984 published by the Office-of Flight Assurance in July 1984 and September 1985 respectively. The current report updates the record through 1985.

Spacecraft Activity Schedule

At the beginning of this reporting period, on January 1, 1985, there were a total of 22 GSFC spacecraft in full or partial service. This number includes 12 meteorological spacecraft operated by NOAA consisting of four of the TIROS/NOAA series, six of the GOES series, Landsat-4, and Landsat-5. During the course of the year one spacecraft failed: GOES-1, which lost its primary instrument due to lamp failure.

There was only one new launch during the year, SPARTAN-1, an attached STS payload, which was successful. The complete list of satellites active during all or part of 1985 is as follows:

NASA		NOAA
AMPTE/CCE		NOAA-6
DE-1	O	NOAA-7
ERBS	N	NOAA-8
IMP-8	G	NOAA-9
ISEE-1	O	GOES-1
ICE (ISEE-3)	I	GOES-2
IUE	N	GOES-3
Nimbus-7	G	GOES-4
SMM		GOES-5
TDRS-1		GOES-6
		Landsat-4
		Landsat-5
SPARTAN-1	NEW	

Details are shown in the Spacecraft Lifetime Data in Appendix A, which includes virtually all GSFC launches since 1960, excluding a number of international missions Goddard participated in but is not considered to have been responsible for.

Overall, there were 56 anomalies, distributed over 23 different spacecraft, during the year. This compares with 67 anomalies distributed over 16 spacecraft in the previous year (1984).

In the following sections, each mission and its Overall performance is discussed in more detail. A complete log of anomalies appears at the end of the report.

Data Sources

The data reported herein are taken primarily from three sources. For NASA spacecraft, the main source is the Spacecraft Orbital Anomaly Reports (SOAR). For TIROS/NOAA spacecraft the TIROS Orbital Anomaly Reports (TOAR) are used, and the GOES Anomaly Reports (GAR) cover the GOES series. These data bases are maintained by the Assurance Requirements Office, in the case of SOAR, and the Metsat Office in the case of TOAR and GAR. The information contained in these reports is originated in the corresponding spacecraft operations control centers. Supplementary information is obtained through miscellaneous written reports, attendance of the regular meetings of the Orbiting Satellites Project, and other verbal contacts. Additional backup information on many of these anomalies is available through this office. In some cases the classifications are not necessarily based on the judgments of this office, and are subject to revision. This applies particularly to "open" anomalies.

Spacecraft Performance Summary

The following provides a summary of the condition and performance of the active spacecraft covered by this report:

AMPTE/CCE

AMPTE, launched August 16, 1984, is an international program consisting of three separate but coordinated spacecraft, all launched by the same Delta vehicle. The United States spacecraft is the Charge Composition Explorer (CCE). Its function is to detect and study "tracer" ions released by the German Ion Release Module (IRM) after the ions have entered the earth's magnetosphere. The third spacecraft is the United Kingdom Subsatellite (UKS) whose purpose is to keep station with the German spacecraft in order to measure local disturbances created in the natural space plasma by the injection of ions in the space plasma by the IRM. The British satellite failed in January 1985 and the German satellite made its last barium release, essentially completing the prime part of the AMPTE mission, in July 1985. In April 1985 the major part of the Hot Plasma Composition Experiment (HPCE) was lost when the Time-of-Flight detector power supply went into an over-current condition and pulled down main converter voltages. This was probably due to the failure of a Tantalum capacitor. In September 1985 the Medium Energy Particle Analyzer (MEPA) stopped sending science data for a couple of ten day periods. The cause is not known (possibly electrostatic discharge on the spacecraft). This has not recurred since.

DE-1

This spacecraft has operated throughout the year without any anomalies. During regular periods through the year, when the sun illuminates the spacecraft at certain angles, it is necessary to exercise power management to prevent temperatures from exceeding critical values to prevent damage. During these periods science operation is somewhat limited.

ERBS

This spacecraft has been performing very well throughout the year. All its scientific objectives have been met. Bit flips in the on-board command memory have been a continuing annoyance during the year, but they have not compromised the mission. A number of tests on the spacecraft and on the ground were conducted to determine the cause of these bit flips - none of them successful. [NOTE: In August 1986 a similar problem surfaced during ground testing of a similar memory for the COBE spacecraft. Both the ERBS and the COBE memories are made by Gulton. The problem appears to be caused by both the Normal and Block memories being enabled simultaneously for a short period of time (20-30 nanoseconds) everytime the logic switches between the Normal and Block memories.]

Geostationary Operational Environmental Satellite (GOES)

GOES-1: This spacecraft functioned as the WEST VISSR spacecraft providing visible-only imaging up to February 3, when the Primary Scan Drive Encoder lamp failed, permanently disabling the instrument. The Redundant Scan Drive Encoder lamp had previously failed. This spacecraft was deactivated on March 7.

GOES-2: This spacecraft served as the Central operational spacecraft at 113°W-during the whole year providing CENTRAL WEFAX service. (VISSR is inoperable and the SEM was not used.)

GOES-3: This spacecraft functioned as the WEST spacecraft for the remainder of the year after replacing GOES-4 on February 5. It provided WEFAX and WEST DCS support. The VISSR is inoperable and the SEM was not used in 1985.

GOES-4: After being replaced by GOES-3 as the WEST spacecraft in February, GOES-4 was moved to 10°W to support ESA DCS operations. In early June RTU-4 failed and was replaced by the redundant unit, RTU-3. Because of a severe interfering signal in the DCS UHF band, GOES-4 could not provide DCS operational support and was repositioned to 43°W in August where it was able to provide ESA DCS operational support. VISSR is inoperable and the SEM was not used.

GOES-5: During 1985, GOES-5 was maintained at 75°W as the EAST spacecraft, providing WEFAX, DCS and SEM support. GOES-6 stretched VISSR data was relayed through GOES-5 to users throughout the year. (VISSR is inoperable.)

GOES-6: This is the only spacecraft with imaging capability and was designated the PRIME spacecraft throughout 1985. It provided visible, IR and VAS imaging and soundings from two orbital positions: 98°W during Summer/Fall and 108°W during Winter/Spring. In early August the Redundant Scan Drive Encoder Lamp-2 failed open and operation shifted to Primary Scan Drive Encoder Lamp-2. In late August a "transient event" caused the temporary loss of both visible and IR video data and switched the operational state of VDM and SEM units. Operations were resumed by command and it was found that a VAS timing error shifted the Earth view window off the earth by 45 degrees.

ISEE-1 (International Sun-Earth Explorer)

No anomalies were reported on this spacecraft in 1985 and operations continued as reported in 1984.

ICE (International Cometary Explorer)(formerly ISEE-3)

This spacecraft successfully rendezvoused with the comet Giacobini-Zimmer in September 1985. It has operated successfully throughout the year with no reported anomalies.

IUE (International Ultraviolet Explorer)

In August 1985 the fourth gyro of six failed. A contingency plan utilizing two gyros and the Fine Sun Sensor had previously been developed and this was put into operation. After testing and minor modification, operation of the spacecraft using this method of attitude control has proved to be satisfactory. Scientific operations continue with no major spacecraft problems.

Landsat-4

No further anomalies were reported on this spacecraft during the year. Despite power problems from the early loss of two solar panels and a nonfunctioning Thematic Mapper, this spacecraft continues to supply data from its Multispectral Scanner (MSS).

Landsat-5

The performance of this spacecraft continues to be excellent with all systems operational including Thematic Mapper and the MSS. No anomaly reports were received in 1985.

Nimbus-7

The last of the Nimbus series, the 7-year old Nimbus-7 continued to provide data from a number of instruments. Three anomaly reports on the TOMS (Total Ozone Mapping Spectrometer) involving chopper dropouts and loss of synchronization were written. These anomalies were intermittent and had only a minor effect on operation. The other anomalies reported during the year were of a very minor nature.

NOAA-6

In mid-January the troublesome and erratic AVHRR stsrted working and providing data. In the early part of the year, to the extent it is operable, NOAA-6 was the "morning" operational spacecraft. (All instruments, except HIRS, are usable.) On July 1 it was placed in standby when NOAA-8 became operational again. However, because of problems developing again with NOAA-8, NOAA-6 was returned to the operational mode in mid-October, although it is degraded in many areas.

NOAA-7

This spacecraft started out the year with a marginal power system but still is capable of supplying good data. However on February 7 the HIRS suffered a hard failure. On February 25, NOAA-7 was replaced by NOAA-9, which became the prime satellite of NOAA. This allowed NOAA-7 to be powered down to simplify power system management. It will be maintained in standby as a backup to NOAA-9. Battery conditions degraded further in April and power management became extremely difficult. A number of battery cells have failed and can only be used operationally when it is in 100% sunlight. There was no change in this standby status as of the end of the year.

NOAA-8

At the beginning of the year NOAA-8 was still out of control as it had been since the middle of 1984 when the Redundant Crystal Oscillator (RXO) malfunctioned. Efforts to bring the spacecraft back into a stable attitude continued. In February a trend toward improvement in clock stability was noted and efforts continued. However, through March and early April attempts to contact the spacecraft were unsuccessful. In late April the spacecraft was successfully contacted and in early May the RXO appears to have finally shifted to the redundant side and became stable at the correct frequency. Using special software the spacecraft was eventually despun using the magnetic torquing coils and reaction wheels. All the spacecraft systems looked good and the instruments were activated and most of them seemed to be ok. The following

problems were identified: the HIRS longwave channels were unusable and the B-detector in one quadrant of the Earth Sensor Assembly had failed, however, attitude control can be maintained with the remaining three quadrants. On July 1, NOAA-8 became operational again as the morning descending satellite replacing NOAA-6. In September the backup RXO began to periodically stop generating clock pulses for short periods of time which caused automatic shut-off of the instruments and putting the spacecraft into a safe state. After the spacecraft was brought back to normal control, it was noted that channel 1 of the SSU saturated and could not be corrected. Due to undependability the spacecraft was placed in the standby mode in October, being used for search and rescue only. At the end of October the clock glitched again resulting in spacecraft tumble. The spacecraft was finally returned to 3-axis stabilization on December 5. However on December 30 another clock glitch set off a series of events culminating in overcharge of battery 1 causing temperature run-away and eventual rupture of the battery. The decision was made not to attempt any more recovery efforts.

NOAA-9

At the beginning of the year, the recently launched NOAA-9 was still in the latter phase of instrument turn-on and checkout. After all instruments were turned on, preliminary evaluation indicated all seemed to be ok except for some noise interference in the HIRS caused by the SSU operation and drift in the SARR downlink frequency which is probably due to a part failure in the transmitter oscillator. In May a switch was made from the SARR transmitter A-side to the B-side. In February the Digital Tape Recorder 1A started acting up and would not properly respond to commands - it appears to be unusable. In March the AVHRR scan motor started exhibiting abnormal slippage causing it to lag behind the MIRP sync at an increasing rate. The problem continued for awhile and eventually was brought under control by operating in a low power mode. Also in March the ERBE Scanner instrument started exhibiting high temperatures indicative of a bearing lubrication problem that has been seen in the similar instrument on the ERBS spacecraft. In April the Digital Tape Recorder 2A became unusable. Other anomalies reported during the year were of a very minor nature. Overall, the spacecraft was operating nominally in the latter part of the year through year's end.

Solar Maximum Mission(SMM)

Throughout 1985 this spacecraft has performed quite well. Only one minor anomaly was reported in 1985, a possible SEU (Single Event Upset) caused an anomaly in the On Board Computer placing the spacecraft in a Safe Hold condition and interrupted science data for 8 days.

SPARTAN-1

This was an attached STS payload mission of seven days launched in June. SPARTAN is an actonym for Shuttle Pointed Autonomous Research Tool for Astronomy. The SPARTAN operated successfully but its scheduled operating time was shortened by 10 hours. This was due to noise on a rate signal that led to excessive valve activity and resulted in early depletion of control gas.

TDRS-1

This satellite completed another year of providing tracking and data relay support to a number of Goddard missions without any major anomalies. There were 12 minor anomalies reported during the year, none of which caused any serious problems. They were all correctable by ground command or modification of operations.

Anomaly Data: Classification and Description

In the table of anomalies the following information is provided:

1. Index -- This is a chronological enumeration of the anomalies, beginning at launch. Numbers lower than the first number used in this report will be found in earlier reports of the series.

2. Date -- This is the date of occurrence of the anomaly, and in parentheses the number of days since launch is given, counting launch day as one.

3. Subsystem -- For the purposes of this data base, the spacecraft is divided into 9 subsystems. These are:

1. Attitude Control and Stabilization (ACS)
2. Power
3. Propulsion
4. Structure/Mechanical
5. Telemetry and Data Handling (T & DH)
6. Thermal
7. Timing, Control and Command (TC & C)
8. Instrument (payload)
9. Other (name to be entered)

4. Criticality -- This describes the impact of the anomaly on the mission, according to the following schedule:

1. Negligible	(O - 5% loss)
2. Non-negligible but Small	(5 - 33%)
3. 1/3 - 2/3 Mission Loss	(33 - 67%)
4. 2/3 to Nearly Total Loss	(67 - 90%)
5. Essentially Total Loss	(90 - 100%)

5. Description -- A brief description of the anomaly and its probable cause, if known.

6. Effect/Action -- The effect of the anomaly on the mission and corrective action, either for this mission or future missions, if any and if known.

7. Reference -- The number on the SOAR, TOAR, or GAR (if any) covering this particular incident.

Anomalies are also classified in various ways for the purpose of statistical analysis. SOAR calls for the following classifications:

ITEM	CODE	DESCRIPTION
Impact:	1	Spacecraft failed
	2	Subsystem or instrument failed
	3	Component failed
	4	Part failed
	5	Indeterminate
Loss of Redundancy	y/n	Yes or No
Failure Category:	1	Design Problem
	2	Workmanship Problem
	3	Part Problem.
	4	Other (w/explanation)
	5	Unknown
Type of Anomaly:	1	Systematic (would recur if identical equipment were operated under identical circumstances)
	2	Random
	3	Wearout (a special case of systematic)
	4	Indeterminate

These classifications for the 1985 anomalies are given in Table I.

Using the data in Table I, the 56 anomalies can be summarized as follows:

Type of Anomaly	No. of Anomalies
Systematic	10
Random	2
Wearout	5
Indeterminate	39

Criticality	No. of Anomalies
Negligible	9
Small	37
1/3 to 2/3 Mission Loss	7
2/3 to Nearly Total Loss	2
Total Loss	1

If the Negligible and Small Criticalities are eliminated, the most serious 10 anomalies (1/3 to Total Loss) can be summarized as follows:

Two (2) anomalies involved loss of redundancy

One (1) was random

Three (3) were due to wearout

Five (5) were indeterminate

The subsystems involved in these 10 anomalies are:

ACS	3
POWER	2
INST.	5

The Failure Category of these 10 anomalies are:

Design Problems	2
Part Problems	3
Other	1
Unknown	4

The Impact of these 10 anomalies are:

Subsystem or Instrument failed	3
Component failed	1
Indeterminate	6

CLASSIFICATION OF 1985 ANOMALIES

Spacecraft	A	B	C	D	E	F	G
AMPTE/CCE	*7*	8	3	2	n	3	*2*
	8	8	2	5	n	5	4
ERBS	7	8	*2*	5	n	5	1
GOES-1	*7*	8	5	*2*	n	3	3
GOES-4	38	*7*	2	3	y	5	4
	39	5	2	5	n	4	1
GOES-5	31	5	*2*	5	n	5	4
GOES-6	12	8	*2*	4	y	3	3
	13	8	2	5	n	5	4
	14	8	*2*	5	n	5	4
IUE	29	7	1	5	n	5	4
	30	1	3	3	y	5	3
NIMBUS-7	30	8	2	5	y	5	4
	31	8	2	5	n	5	4
	32	2	1	5	n	4	3
	33	8	1	5	n	5	4
	34	5	2	5	y	4	4
	35	8	2	5	y	5	4
NOAA-6	37	5	2	5	n	5	4
NOAA-7	27	8	4	2	n	5	4
	28	5	2	5	n	4	4
NOAA-8	13	1	2	4	y	4	1
	14	5	2	5	n	4	4
	15	7	2	5	n	5	4
	16	8	2	5	n	5	4
	17	7	2	5	n	5	4
	18	1	4	5	n	4	4
	19	2	2	5	n	5	4
NOAA-9	3	8	2	4	n	3	1
	4	5	2	5	n	5	4
	5	8	*2*	5	n	5	4
	6	8	2	5	n	5	4
	7	5	2	5	n	5	4
	8	8	2	5	n	5	4
	9	8	3	5	n	3	4
	10	8	2	5	y	5	4
	11	2	3	5	n	5	4
	12	8	3	5	n	1	3
	13	2	3	5	y	5	4
	14	8	2	5	n	5	4
	15	8	2	5	n	5	4
	16	8	2	5	n	5	4
SMM	46	7	1	5	n	5	2
SPARTAN-1	1	1	3	5	n	1	1
TDRS-1	29	7	1	5	n	1	1
	30	1	1	3	n	5	1
	31	8	2	5	n	4	4
	32	5	2	5	n	1	1
	33	1	2	5	n	5	4
	34	1	1	5	n	5	1
	35	1	2	5	n	5	4
	36	8	1	5	n	5	4
	37	8	1	5	n	5	4
	38	8	2	5	n	5	4
	39	2	2	5	n	4	1
	40	7	2	5	n	5	4

A = Index

B = Subsystem

C = Criticality (Mission Effect)

D = Impact

E = Loss of Redundancy

F = Failure Category

G = Type of Anomaly

TABLE I

INDEX	DATE/(DAYS)	SUBSYSTEM	CRITICALITY	DESCRIPTION	EFFECT/ACTION	REF.
				AMPTE/CCE		
7	4/4/85 (231)	INST-HPCE	3	Time-of-Flight detector power supply went into over-current condition & pulled down main converetr voltages.	Lost major part of HPCE.	A00712
8	9/22/85 (402)	INST-MEPA	2	Science data stopped for a couple of 10 day periods over a month's time. Cause not known.	Has not occurred since 10/85.	A00996
				DE-1		
				NO ANOMALIES REPORTED IN 1985		
				ERBS		
7	5/2/85 (209)	INST-ERBE SCNR	2	Intermittent sticking (20-30 secs each) of scanner over 6 hour period. Probably due to lube loss in bearings.	Has not recurred.	A00901
				GOES-1		
7	2/3/85 (3398)	INST-VISSR	5	Primary Scan Drive Encoder lamp failed, disabling VISSR.	S/C deactivated on March 7.	
				GOES-2, -3		
				NO ANOMALIES REPORTED IN 1985		
				GOES-4		
38	6/4/85 (1729)	TC & C	2	Erroneous analog & bilevel PCM TLM words. RTU-4 failed.		91

INDEX	DATE/(DAYS)	SUBSYSTEM	CRITICALITY	DESCRIPTION	EFFECT/ACTION	REF.
39	6/25/85 (1750)	TLM & DH	2	Interfering signal in DCPR pass band impacting ESA DCS support. Cause: EMI	S/C moved to 44°W, away from interfer.	92
				GOES-5		
31	12/29/85 (1682)	TLM & DH	2	CDA TLM XMTR 2 output power decrease.		96
				GOES-6		
12	8/6/85 (831)	INST-VAS	2	Redundant Scan Drive Encoder lamp 2 failed. Cause: Exceeded normal lamp life.	Lost redundancy/ switched to lamp I	93
13	8/25/85 (850)	INST-VAS	2	Transient "Event" shifted VAS Earth view window & changed mode of VDM & SEM.		94
14	10/25/85 (911)	INST-VAS & TLM & DH	2	VISSR image shifts when STDN TLM XMTR & RNG XPNDR powered on.		95
				ISEE-1, -3(ICE)		
				NO ANOMALIES REPORTED IN 1985		
				IUE		
29	7/18/85 (2730)	TC & C	1	OBC unable to control S/C attitude during orbit adjust inaneuver - cause unknown.	Orbit adjust done 8/9/85	A00793
30	8/17/85 (2760)	ACS	3	Rate Gyro No. 3 failed. Cause unknown. (4th gyro to fail on IUE)	Changed to 2- gyro/FSS mode of operation.	A00795
				LANDSAT-4, LANDSAT-5		
				NO ANOMALIES REPORTED IN 1985		

INDEX	DATE/(DAYS)	SUBSYSTEM	CRITICALITY	DESCRIPTION	EFFECT/ACTION	REF.
				NIMBUS-7		
30	3/1/85 (2320)	INST-TOMS	2	TOMS chopper went out of sync about 15 times/orbit since 3/84. Cause unknown.	Minor effect on operations.	A00821
31	4/13/85 (2363)	INST-TOMS	2	Scan/comp. motors lost sync twice.	Minor effect. Intermittent.	A00815 A00818
32	5/1/85 (2381)	POWER	1	Reg. bus volt. increase to -25.1(slightly out of spec). Gradual change since launch.	Negligible effect	A00817
33	7/3/85 (2444)	INST-ERB	1	Chan. 12 failed to switch to wide FOV. TLM indicates change of state to wide FOV. Output says narrow FOV.	After reset, worked OK.	A00819
34	8/18/85 (2490)	TLM & DH	2	TR-3 failed to move in record direction when cmded for DIP data. Cause unknown.	Worked OK on 8/19/85	A00820
35	12/24/85 (2618)	INST-TOMS	2	Increase in number of chopper drop-outs & motor current occurred at N/D transit.	Same as Index 30, above.	A00822
				NOAA-6		
37	3/8/85 (2081)	TLM & DH	2	HRPT video chan 3 & 4 show coherent noise in IR data. Vis. chan 1 & 2 OK. Cause unknown.	Minor/software patch to fix not recommended.	00222
				NOAA-7		
27	2/7/85 (1325)	INST-HIRS	4	Hard failure of IIIRS. Data output suddenly shifted. Motor Littering, filter wheel seized.	Loss of HIRS data.	00225

INDEX	DATE/(DAYS)	SUBSYSTEM	CRITICALITY	DESCRIPTION	EFFECT/ACTION	REF.
28	3/13/85 (1359)	TLM & DH	2	TIP 1 cal voltage exceeded op. specs. TIP 2 has not been tested in orbit. Cause unknown.	Minor effect.	00224
				NOAA-8		
13	5/10/85 (774)	ACS	2	MMCA B Detector output of ESA quadrant 3 is high & unusable. Cause: detector disconnected during out-of-control tumble.	Minor/software patch to fix not recommended	00233
14	8/22/85 (878)	TLM & DH	2	SATCU Chan 5 varies btwn 36 & 8 Deg. Caused by high stress of S/C tumble.	Minor effect.	00235
15	9/8/85 (895)	TC & C	2	Anomolous function of backup RXO caused CPU & bus switch. BU oven TLM wildly fluctuating. Cause unknown.	Minor effect.	00236
16	9/16/85 (903)	INST-SSU	2	SSU Ch 1 saturated due to gain change in amplifier/conditioning network.	Condition is permanent/No corr. action.	00237
17	9/30/85 (917)	TC & C	2	CPU-1 select command did not result in expected status until sent 2nd time.	Norm. response of CIU & s/w.	00238
18	10/1/85 (918)	ACS	4	Following command of ESA to primary, bus & CPU switched. Cause unknown.	Norm. response of software.	00239
19	12/8/85 (986)	POWER	2	Batt. 1 charge reg. failed to taper from 6 amps. Cause unknown.	Minor effect.	00242
				NOAA-9		
3	1/9/85 (28)	INST-SARR	2	Downlink frequency drift. Probably a part failure in transmitter oscillator.	May degrade Inst. perform.	00221
4	1/9/85 (28)	TLM & DH	2	DTR 2A failed to P/B data on one orbit- no head P/B volt. & high servo error.	Negligible effect/subs. use normal .	00216 00232

INDEX	DATE/(DAYS)	SUBSYSTEM	CRITICALITY	DESCRIPTION	EFFECT/ACTION	REF.
5	1/9/85 (28)	INST-SSU	2	SSU causes noise on long wave channels of HIRS instrument. Short-wave not affected.	Negligible effect/	00230
6	1/15/85 (34)	INST-AVHRR	2	Noise on AVHRR chan. 3 exceeds spec. Cause unknown.	May limit operation.	00231
7	2/12/85 (62)	TLM & DH	2	DTR 1A current increases to 450 ma following LAC Rec. off cmd. Cause unknown.	May limit operation.	00218
8	2/25/85 (75)	INST-SARP	2	SARP internal time code took a 106 sec. step. Cause unknown.	May limit operation.	00220
9	3/12/85 (90)	INST-AVHRR	3	Abnormal slippage in AVHRR Scan motor. Slippage increasing by constant rate. Cause unknown.	Does not iinpare use.	00226
10	3/12/85 (90)	INST-DCS	2	VSO in DCS Rcvr 1 developed noise. Switched to redundant Rcvr 2. Cause unknown.	Reduces redundancy.	00227
11	3/13/85 (91)	POWER	3	SAD motor current chan. 350 shows spikes to 4.5 v during dwell test at 1 sec. rate. Cause unknown.	Minor effect at this time.	00223
12	3/19/85 (97)	INST-ERBE-S	3	Temp. on ERBE Scanner high. Lube problem in bearings probable cause	May get worse.	00228
13	4/26/85 (135)	POWER	3	Batt. 1 chg current dropped suddenly from 6 A. to 700 ma. Cause unknown.	Degrades redundancy/No corr. action.	00234
14	11/26/85 (349)	INST-AVHRR	2	Ch 3 shows coherent noise. Cause unknown.	Reduces output of sea surface temps at night.	00243
15	11/26/85 (349)	INST-MSU	2	MSU Encoder line count jumped more than allowable.	No problem.	00241
16	11/26/85 (349)	INST-MSU	2	Ch 3 gain has increased by a factor of 0.53 since launch. Cause unknown.	Check relation to TOAR 00241.	00240

INDEX	DATE/(DAYS)	SUBSYSTEM	CRITICALITY	DESCRIPTION	EFFECT/ACTION	REF.
				SMM		
46	11/26/85 (519)	TC & C	1	S/C commanded into safehold attitude inode due to anomaly in OBC. Cause unknown.	Lost 8 days of science/reloaded OBC.	A01019
				SPARTAN-1		
1	6/21/85 (1)	ACS	3	Pointing program terminated 10 hours early due to depletion of control gas early due to noise on rate signal causing excessive valve activity.	Lost 10 hours of data.	A00987
				TDRS-1		
29	1/21/85 (658)	TC & C	1	When ETO-A started cmd execution, TLM indicated no execution or invalid response. Caused by cmd up-linking during TLM sampling time.	Negligible/No Corr. Action possible.	A00925 A00926
30	1/21/85 (658)	ACS	1	Both +Y & -Y solar arrays stopped clocking in same time frame of an ETO.	Negligible effect.	A00924
31	3/8/85 (704)	INST-DATA RELAY	2	KSA2R channel power level dropped 2 dB.	Minor effect. Monitor for further change.	A01178
32	4/9/85 (736)	TLM & DH	2	Suspected contaminates may have caused LCP/RCP switch to stick.	Lost KSA-2 service for a period.	A00932
33	4/24/85 (751)	ACS	2	Pitch computation glitched causing error in North & South ESA scans telemetry.	Corrected itself. RAM hit suspected.	A01179
34	4/25/85 (752)	ACS	1	After a RAM dump, some of the ACS TLM is corrupted with the RAM dump values. Cause unknown.	S/C dynamically responded to corrupted values.	A00972

INDEX	DATE/(DAYS)	SUBSYSTEM	CRITICALITY	DESCRIPTION	EFFECT/ACTION	REF.
35	5/5/85 (762)	ACS	2	North earth sensor parameter had a 0.1 degree error. Error stays constant.	Minor effect.	A01180
36	5/25/85 (782)	INST-DATA RELAY	1	TWT 12Cl experienced several jumps in helix current. Cause unknown.	Negligible effect.	A00973
37	6/5/85 (793)	INST-DATA RELAY	1	SA-2 antenna slewed to -14 deg pitch & +17 deg roll. Cause unknown.	Neglig. effect/ Slew stopped by ground cmd.	A00974
38	6/27/85 (815)	INST-DATA RELAY	2	SA-1 antenna null search unsuccessful in pitch gimbal. Cause unknown.	User S/C support affected. Search stopped by ground command.	A00975
39	7/15/85 (833)	POWER	2	Solar arrays stopped clocking: -Y at 270 deg. & +Y at 223 deg. Both should be at 285 deg.	Corrected by ground command	A01181
40	12/19/85 (990)	TC & C	2	Reseting of CVU enable/disable latch caused the S/C to go thru an ETO.	Minor effect.	A01182

APPENDIX A

SPACECRAFT LIFETIME DATA

Note: In the following table, the term "useful life" refers to the time during which the major mission objectives were met. Active life is the total lifetime during which the satellite remained in service. A blank space means the information was not available. Data is through 1985; see text for update.

SPACECRAFT	LAUNCH DATE	DESIGN LIFE (YRS)	USEFUL LIFE (YRS)	ACTIVE LIFE (YRS)	REMARKS
TIROS	4/1/60	0.25	.24	.24	TV system useful for 77 days
Explorer VIII (S-30)	11/3/60	0.25	.15	.15	Last transmission 12/28/60
TIROS-II	11/23/60		.63	1.03	TV data useful to 7/12/61
Explorer XI (S-15)	4/27/61		.61	.61	Last transmission 12/7/61
TIROS-III	7/12/61	.25	.40	.63	TV data useful to 12/4/61. Lost tape recorders.
Explorer XII (S-3)	8/15/61	1.0	.31	.31	Transmission ceased abruptly
TIROS-IV	2/8/62	0.25	.36	.44	TV useful to 6/9/62. Lost tape recorders.
OSO-I	3/7/62	0.5	1.40	1.40	Lost tape recorder @ 2 mos. starfish incident degraded power system.
Ariel-I (S-51)	4/26/62	1.0	0.88		Degraded by starfish incident of 7/9/62.
TIROS-V	6/19/62	0.5	0.88	0.88	TV useful to 5/4/63. Camera filaments failed.
TIROS-VI	9/18/62	0.5	1.06	1.06	TV useful to 10/11/63. Filaments and focus out.
Explorer XIV (S-3a)	10/2/62		0.85	1.20	Last transmission 2/17/64
Explorer XV (S-3b)	10/27/62	0.17	0.26	0.55	Despin system failed. Last transmission 5/19/63.
Relay I	12/13/62	2.0	2.53	2.53	
Syncom I	2/14/63	2.0	0	0	Lost power, mission failure.
Explorer XVII (S-6)	4/3/63	0.25	.27	.27	Batteries degraded. No solar array.
TIROS-VII	6/19/63	0.5	4.33	4.96	Deactivated. Camera focus out 12/65.
Syncom II	7/26/63	2.0	N/A	N/A	
IMP-A	11/26/63	1.0	0.82		
TIROS-VIII	12/21/63	0.5	3.53	3.53	Deactivated.
Relay-II	1/21/64	1.0	1.68	3.50	
Ariel-II (S-52)	3/27/64	1.0	0.53		Had spin rate and attitude control problems.
Syncom III	8/19/64	3.0	N/A	N/A	
Explorer XX (S-48)	8/25/64		1.60	1.60	Based on last transmission 3/30/66.
Nimbus-I	8/28/64	0.5	0.07	0.07	Solar array drive failed.
OGO-1(A)	9/4/64	1.0	5.23	5.23	Mission failure. 3-axis stabilization not achieved.
IMP-B	10/3/64	1.0	0.50	1.25	Reentered. Placed in wrong orbit.
Explorer XXVI (S-3c)	12/21/64	1.0	2.10	2.10	Last transmission 1/21/67.
TIROS-IX	1/22/65	0.5	2.73	3.4	Deactivated. Camera contrast out 10/66.
OSO-II	2/3/65	0.5	0.75	0.75	Used up control gas.
IMP-1(C)	5/29/65	1.0	1.92	1.92	Reentered.
TIROS-X	7/2/65	1.0	1.16	2.00	Deactivated.

SPACECRAFT	LAUNCH DATE	DESIGN LIFE (YRS)	USEFUL LIFE (YRS)	ACTIVE LIFE (YRS)	REMARKS
OGO-2(C)	10/14/65	1.0	3.48		Mission failure: Horizon scanners did not maintain earth lock.
ESSA-I	2/3/66	1.0	2.36	2.36	Deactivated.
ESSA-II	2/28/66	1.0	4.64	4.64	Deactivated.
OAO-I	4/8/66	1.0	0	0	Mission failure: Lost power
Nimbus-II	5/16/66	0.5	2.67	2.67	ACS scanner failed.
AE-B	5/25/66	0.5	0.82		Higher than planned orbit. Two sensors did not work.
OGO-3(B)	6/6/66	1.0	2.04	3.5	Boom oscillation problem.
AIMP-2(D)	7/1/66	0.5	4.92		Failed to achieve lunar orbit.
ESSA-III	10/2/66	1.0	2.02	2.02	Deactivated. Cameras failed
ATS-I	12/6/66	3.0		ACTIVE	Gas expended. Limited service
ESSA-IV	1/26/67	1.0	0.41	1.27	Deactivated. One camera failed, one degraded.
OSO-III	3/8/67	0.5	3.0	3.0	Tape recorder failure at 18 mos. ACS controlled manually.
ESSA-V	4/20/67	1.0	2.83	2.83	Deactivated. IR failed, cameras gradually degraded.
IMP-3(F)	5/24/67	1.0	1.95	1.95	Reentered.
AIMP-4(E)	7/19/67		3.50	3.50	Lunar orbit. Subsequent period of intermittent operation.
OGO-4(D)	7/28/67	1.0	2.24	2.75	Thermal bending of antenna caused stabilization control problem.
OSO-IV	10/18/67	0.5	0.90		Tape recorder failure at 6 mos.
ATS-III	11/5/67	3.0		ACTIVE	Instruments no longer in use
ESSA-VI	11/10/67	1.0	2.09	2.09	Deactivated Cameras degraded
OGO-5(E)	3/4/68	1.0	3.60	3.60	Deactivated. Data glut
RAE-A	7/4/68	1.0	4.50	4.50	Deactivated. Data quality had become marginal.
ESSA-VII	8/16/68	1.0	0.92	1.56	Deactivated. Early camera and tape recorder failures
OAO-II	12/7/68	1.0	4.20	4.20	Prime instrument (WEP) failed.
ESSA-VIII	12/15/68	1.0	4.95	6.75	Deactivated. Camera problems
OSO-V	1/22/69	0.5	3.9	3.9	
ESSA-IX	2/26/69		4.1	4.1	Deactivated. Standby after 4/71.
Nimbus-3	4/19/69	0.5	2.67		ACS Scanner failed 1/72.
OGO-6 (F)	6/5/69	1.0	2.06	2.25	Deactivated. Data glut
IMP-5(G)	6/21/69		3.51	3.51	Reentered.
OSO-VI	8/9/69	0.5	3.30	3.30	

SPACECRAFT	LAUNCH DATE	DESIGN LIFE (YRS)	USEFUL LIFE (YRS)	ACTIVE LIFE (YRS)	REMARKS
ATS V	8/12/69	3.0	14.84	14.84	Mission officially unsuccessful: Stabilization not achieved. Deorbited 3/20/84
TIROS-M	1/23/70	1.0	1.40	1.40	Momentum wheel assembly failed.
Nimbus-4	4/8/70	1.0	10.00	10.00	Deactivated.
NOAA-1 (ITOS-A)	12/11/70	1.0	.56	0.75	Deactivated. Momentum wheel assembly problems.
SAS-A	12/12/70	0.5	4.00	4.00	Transmitter failure terminated mission.
IMP-6(I)	3/13/71	1.0	3.56	3.56	Reentered.
OSO-VII	9/29/71	0.5	3.17	3.17	Reentered due to bad orbit
SSS-A	11/15/71	1.0	2.87	2.87	Deactivated. Battery unusable, as expected after 1 year.
Landsat-1 (ERTS-A)	7/23/72	1.0	5.58	5.58	Deactivated: Funding withdrawn
OAO-C	8/21/72	1.0	8.50	8.50	Deactivated: Funding withdrawn
IMP-7(H)	9/22/72	2.0	6.10	6.10	Power system failed.
NOAA-2 (ITOS-D)	10/15/72	1.0	2.25	2.40	Standby after 3/74. Some experiments failed.
SAS-B	11/16/72	0.5	.54	.54	Experiment low voltage power supply failed.
Nimbus-5	12/12/72	1.0	10.30	10.30	Deactivated 3/31/83. Second HDRSS failed 7/27/82.
RAE-B	6/10/73	1.0	3.75	3.75	Deactivated. Mission objectives achieved.
IMP-8(J)	10/25/73	2.0	ACTIVE	ACTIVE	All instruments operating.
NOAA-3 (ITOS-F)	11/6/73	1.0	2.84	2.84	Deactivated. Radiometer, VTPR, VHRR out
AE-C	12/16/73	1.0	5.00	5.00	Reentered.
SMS-1	5/17/74	2.0	1.60	6.70	Standby after 1/76. Deactivated 1/31/81.
ATS-6(F)	5/30/74	5.0	5.17	5.17	Deactivated.
NOAA-4 (ITOS-G)	11/15/74	1.0	4.00	4.00	Deactivated. Radiometer, VHRR's out.
Landsat-2	1/22/75	1.0	8.51	8.51	Yaw flywheel stopped 11/79, recovered 5/80. Permanently turned off July 27, 1983.
SMS-2(B)	2/6/75	2.0	6.50	7.50	Second encoder failed on 8/5/81.
SAS-C	5/7/75	1.0	4.92	4.92	Reentered.
Nimbus-6(F)	6/12/75	1.0	7.18	8.28	Yaw flywheel failed 8/14/82.
OSO-8(I)	6/21/75	1.0	3.40	3.40	Funding withdrawn
AE-D	10/6/75	1.0	0.42	0.42	Shorted diode in power supply electronics.
GOES-1(A)	10/16/75	3.0		9.3	VISSR failed 2/85
AE-E	11/20/75	1.0	5.56	5.56	Reentered 6/10/81
NOAA-5 (ITOS-H)	7/29/76	1.0	2.96	2.96	Failed 7/79

SPACECRAFT	LAUNCH DATE	DESIGN LIFE (YRS)	USEFUL LIFE (YRS)	ACTIVE LIFE (YRS)	REMARKS
GOES-2 (B)	6/16/77	3.0	1.55	1.55	VISSR failed 1/79
ISEE-1(A)	10/22/77	2.0	ACTIVE	ACTIVE	Some instrument losses
IUE	1/26/78	3.0	ACTIVE	ACTIVE	Fully operational. Some problems w/ computer "HALTS"
Landsat-3(C)	3/5/78	3.0	5.07	5.51	Problems with MSS instrument
AEM-A (HCMM)	4/26/78	1.0	2.40	2.40	Deactivated. Battery degraded 9/14/80.
GOES-3(C)	6/16/78	3.0	2.21	ACTIVE	VISSR degraded 9/80. Failed 5/6/81.
ISEE-3(C) [ICE]	8/12/78	2.0	ACTIVE	ACTIVE	Some instrument losses.
TIROS-N	10/13/78	2.0	2.38	2.38	ACS failed 2/27/81.
Nimbus-7(G)	10/24/78	1.0	ACTIVE	ACTIVE	Solar array power and some instruments degraded.
AEM-B (SAGE)	2/18/79	1.0	2.75	2.75	Battery degraded. Failed 11/18/81.
NOAA-6(A)	6/27/79	2.0	ACTIVE	ACTIVE	Much degraded. HIRS failed.
Magsat	10/30/79	0.4	.61	.61	Reentered as planned 6/11/80
SMM	2/14/80	2.0	0.83*	ACTIVE	Lost fine pointing control 12/12/80.
GOES-4(D)	9/9/80	7.0	2.21	2.21	VAS failed 11/25/82.
GOES-5(E)	5/22/81	7.0	ACTIVE	ACTIVE	VISSR inoperable
NOAA-7(C)	6/23/81	2.0	3.62	ACTIVE	Failed HIRS, degraded SSU, disabled power system.
DE-1(A)	8/3/81	1.0	ACTIVE	ACTIVE	
DE-2(B)	8/3/81	1.0	1.54	1.54	Reentered as expected 2/19/83.
OSS-1	3/22/82	--	--	--	Shuttle attached payload mission.
Landsat-4(D)	7/16/82	3.0	ACTIVE	ACTIVE	
NOAA-8(E)	3/28/83	2.0	--	--	Failed 7/1/84. Recovered May 1985. Failed again 1/86.
TDRS-1(A)	4/4/83	**	ACTIVE	ACTIVE	Some loss of capability.
GOES-6(F)	4/28/83	7.0	ACTIVE	ACTIVE	
Landsat-5(D')	3/1/84	3.0	ACTIVE	ACTIVE	
AMPTE/CCE	8/16/84	1.0	ACTIVE	ACTIVE	
ERBS	10/5/84	2.0	ACTIVE	ACTIVE	
NOAA-9(F)	12/12/84	2.0	ACTIVE	ACTIVE	
SPARTAN-1	6/20/85	--	--	--	STS attached payload mission

* Repaired by crew of shuttle flight 41-C on April 12, 1984.
** Complex warranty provisions call essentially for 10-year service from TDRSS system.